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COMPLIMENTS OF
THE AUTHOR.

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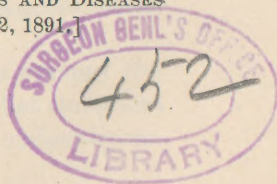
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HAND DISINFECTION.¹

“SEPSIS” is a technical term designating an intoxication proceeding from certain forms of necrobiosis, or destruction of the minuter elements of the tissues.

The recognition of the direct dependence of such destructive changes upon the action of micro-organisms is now the very alphabet of the bacteriological laboratory and the keystone of the most important recent advances in pathology. The occurrence of sepsis in the human body is also acknowledged by every surgeon who employs the terms “antiseptis” and “asepsis,” and I know of no educated medical man to-day who does not include them in his vocabulary.

Suppuration is but one of the phenomena (conservative) attending the efforts of certain definite forms of germs to invade the tissues.

The common germs of suppurative wounds are the *staphylococcus pyogenes aureus*, the *staphylococcus pyogenes albus*, and the *streptococcus pyogenes*.

Prevent the invasion of these germs and you prevent the necessity for suppuration. The magnitude of that statement I need not discuss in the presence of a body of eminent practical surgeons.

Disinfection is any means put in action for removal or destruction of these pathogenic germs.

Disinfection of *instruments* and *dressings* by means of steam, and that by Arnold's steam-sterilizer, as tested and introduced by the Johns Hopkins Hospital, absolutely frees our armamentarium from this living danger.

But two important avenues of infection remain—the *hands*

¹ Read at the fourth annual meeting of the Southern Surgical and Gynecological Association, at Richmond, November 11th, 1891.

of the surgeon, which will contaminate the wound, and the patient's own body (auto-inoculation or auto-infection).

My recent investigations have led me to important conclusions relative to both of these sources of infection. To-day I shall speak only of the former.

I will present my thesis in a series of postulates, which will be defended by a parallel series of crucial experiments¹ which consist in cultures taken from the hands both before and after using the various disinfecting agents.

The method of taking these cultures is as follows:

The steel blade of a scalpel is brought to a white heat and then allowed to cool. With this a visible amount of the epidermis is scraped from the palmar surface of the hand, or some of the tissue is removed from under the nail.

The platinum wire, mounted in a glass handle and used for inoculating the tubes, is heated white hot, allowed to cool, and by its means the material on the knife blade is transferred to the culture medium. The culture tube, containing sterilized gelatin or agar-agar, is held obliquely as the cotton plug is carefully withdrawn and the gelatin or agar stabbed with the inoculated platinum needle, when the plug is at once replaced. To discern the separate colonies the better, the agar is liquefied by heat and cooled by rolling it nearly horizontally on a block of ice. In this way the germs are widely distributed over a thin layer, and "roll cultures" are obtained after the tubes have remained several days in the thermostat.

I. *The Presence of Germs on the Hands.*—The *staphylococcus pyogenes albus*, and sometimes the *aureus*, are present in enormous numbers on the hands and about the nails of every individual associated with medical work in this community. This is demonstrated by all the experiments I have conducted.

II. *The Inadequacy of Soap and Water to remove all Germs.*—The ordinary practice of washing the hands thoroughly for from five to twenty-five minutes, with soap and water and a scrubbing brush, is utterly inadequate to remove all the germs.

¹I acknowledge with pleasure my indebtedness to my co-workers, Drs. Hunter Robb and Albert A. Ghiskey, gynecological resident and gynecological assistant in the Johns Hopkins Hospital.

The undoubted value of such a procedure lies in the fact that it constitutes the best form of mechanical disinfection, removing all easily detachable epithelial and subungual débris loaded with germs, thus reducing the chances of conveying infection to those more firmly seated.

Sixty-five experiments were made with doctors who scrubbed their hands *ad libitum* (ten to twenty-five minutes) with strong brown soap and hot water frequently changed.

Eleven of these were outside of the gynecological staff, and some who came from a distance felt quite sure of their ability to secure aseptic hands with soap and water alone. *In every instance* of the eleven, *myriads of coccal*¹ *colonies developed*.

In the remaining *fifty-four* cultures, taken from my gynecological assistants and myself, all but nine yielded numerous colonies. These nine are mentioned for accuracy's sake; they are to be explained by the inhibiting power of bichloride of mercury used as far back as the day previous, as will be shown further on.

In seven additional experiments with nurses scrubbing their hands with soap and water, temperature 40° C. (104°F.), for ten minutes, the results are all positive, developing from forty to six hundred, and inestimable, colonies of *staphylococcus albus* and a few of *aureus*.

In each instance it was known that the test was about to be made, and all endeavored, by unusually vigorous efforts, to earn the credit of "no growth."

III. *Bichloride of Mercury*² *Solutions as strong as 1 : 500 are not germicidal* after immersion of the hands for from two to five minutes. The mercuric salt acts either by mechanically coating or chemically combining with some portion of the coccus, thus *only inhibiting further growth* until the salt is precipitated or removed.

This I have repeatedly shown to be true following both the ordinary practice of immersion of the hands from two to five minutes in 1 : 500 and 1 : 1,000 solutions, after a preliminary washing for ten minutes with soap and water, and again after carefully following out Fürbringer's method, now so generally adopted.

¹ In almost all instances the *staphylococcus pyogenes albus*.

² Merck's recrystallized.

The latter method was distinctly shown to be inefficient in almost every instance. It is briefly the following:

Clean the nails with a pointed steel.

Scrub the hands, especially the nails, one minute with soap and hot water and a sterilized brush.

Immerse the hands in alcohol (not under eighty per cent) for one minute; immediately transfer hands, still wet with the alcohol, to a freshly-prepared solution of mercuric bichloride, 1:500, for one minute, when they are supposed to be sterile.

I exhibit in my hand four tubes carrying cultures which failed to develop after sterilizing by this method, illusively showing an apparent sterility, for here, on the other hand, are the cultures taken from the same fingers *after precipitating the bichloride with a sterile ammonium sulphide solution, and these show innumerable colonies.*

These particular experiments were made in the ordinary manner last Saturday, and are, I assure you, in no way selected for a demonstration. It is a remarkable fact, of great practical importance, that this inhibiting effect of the bichloride holds over on the hands for twenty-four hours. In two instances of men who had been away from the hospital for from four to six weeks, the ammonium sulphide produced the characteristic dark stain on the fingers showing the presence of bichloride. Here is the source of error explaining the nine negative results in the hands of my staff after simple soap-and-water cleansing. We did not then know of this property of the sublimate.

Four experiments were also made with a four-per-cent solution of lysol; all yielded colonies.

Three experiments with peroxide of hydrogen also furnished abundant colonies.

IV. *Solutions of Potassium Permanganate and Oxalic Acid the best Germicides.*—My experiments have demonstrated that the permanganate of potash, applied to the hands in saturated solution, and then decolorized by a saturated solution of oxalic acid, is the most efficient germicide in our possession.

I have followed this practice in all my abdominal operations for over two years, and I here present the scientific

grounds for rehabilitating this old and well-known disinfectant in this particular field. My method of disinfection is:

1. Scrubbing the hands, with especial attention to the nails—not more than one millimetre in length—for ten minutes in water frequently changed, at about 40° C. (104° F.).

2. Immersion of the hands in a solution of permanganate of potash, made by adding an excess of the salt to boiling distilled water,¹ until every part of the hands and lower fore-arms is stained a deep mahogany red or almost black color. They are then transferred at once to a saturated solution of oxalic acid until completely decolorized and of a healthy pink color. This decolorization is accompanied by a sense of warmth, due to chemical reaction, and a sharp stinging wherever there is any abrasion of the epidermis.

3. Washing off the oxalic acid in warm sterilized water.

By this simple process the hands are rendered more nearly absolutely aseptic than by any other known means.

In fifty experiments after disinfection by this method, forty-four remained without growth; the remaining six yielded respectively eighty, twenty, ten, nine, five, four colonies—an enormous quantitative difference in favor of permanganate of potash and oxalic acid, as contrasted with soap-and-water and corrosive sublimate.

In conclusion, let me briefly recapitulate the gist of this most important matter.

- I. Staphylococci (mostly albus) were present on the hands of all persons examined.

- II. It is impossible to get rid of these staphylococci by scrubbing the hands and nails from ten to twenty-five minutes with a sterilized brush, soap, and water, temperature 40° C. (104° F.).

- (a) Demonstrated by countless colonies developed in one hundred per cent of cases examined—nurses and doctors whose hands were infrequently or not at all immersed in bichloride solutions.

- III. The bichloride of mercury solutions as used, up to 1:500, are not germicidal, as supposed.

¹ Cold water takes up from four to five per cent, boiling water twenty-five per cent.; the excess is redeposited on cooling.

(a) Previous erroneous conclusions as to the efficiency of the bichloride shown to be due to an inhibiting action which may persist at least twenty-four hours after the last use of the drug.

(b) Precipitation of the bichloride on the fingers with a sterile ammonium hydrosulphuret solution yields numerous colonies, after complete failure to develop before precipitating.

(c) This statement holds good also of Fürbringer's method, which failed to show germicidal properties.

(d) Hydrogen peroxide and lysol (four per cent) were tested and found wanting.

IV. The germicidal properties of a saturated solution of potassium permanganate, followed by its neutralization in a saturated solution of oxalic acid, supported by

(a) Large number of experiments in which no colonies at all developed, immediately after the demonstration of countless colonies after soap and water.

(b) In the low percentage of cases in which germs developed the number of colonies was small and definite.

In the present state of our bacteriological knowledge as to the causes of inflammation and suppuration, we are bound to use every means in our power to avoid sowing any unnecessary germs in our wounds. Soap and water are, I believe, the best disinfectants, if we use but one, for they remove all germs which will come away easily. The bichloride of mercury, although dangerous on wounds on account of its property of coagulating and causing necrosis of albuminous tissues, has the valuable property of inhibiting those germs with which it comes into contact. Permanganate of potash and oxalic acid are harmless to the hands and are germicidal. Soap and water plus the permanganate of potash and oxalic acid are the only true germicides and therefore the best disinfectants we possess to-day.



